### Association Between Teacher Salaries and Per Capita Gross Domestic Product

Teacher salaries relative to per capita gross domestic product (GDP) are an indication of the extent to which a country invests in teaching resources relative to the financial ability to fund educational expenditures. A high salary relative to per capita GDP suggests that a country is making more of an effort to invest its financial resources in teachers. Relative to per capita GDP, teacher salaries are relatively low in the Czech Republic, Hungary, and Norway and relatively high in South Korea, Spain, and Switzerland.

Wealthier countries do not necessarily spend a greater share of their wealth on educational resources, however. (See figure 1-16.) Although the Czech Republic and Hungary have both relatively low GDP per capita and low teacher salaries, other countries with GDP per capita below the OECD average, including South Korea and Spain, have comparatively high teacher salaries. Norway and the United States, two countries with relatively high GDP per capita, spend a below-average share of their wealth on teacher salaries, and Switzerland spends an above-average share of its relatively high per capita GDP on teacher salaries.

### Salaries Adjusted for Statutory Teaching Time

Another measure of the investment in teaching is the statutory teacher salary relative to the number of hours per year that a full-time classroom teacher is required to teach students. This measure reflects the fact that teaching time is organized differently across countries, influenced by both the number of instructional hours planned for students each year and the proportion of the working day that a full-time teacher is expected to be engaged in direct instruction. Although this measure does not adjust salaries for the amount of time that teachers spend in all teaching-related activities, it can nonetheless provide a rough estimate of the cost of an hour of instruction across countries.

The average statutory salary per teaching hour after 15 years of experience is $35 in primary education, $43 in lower secondary education, and $52 in upper secondary (general) education across OECD countries (OECD 2000). For primary education, the Czech Republic, Hungary, and Mexico have relatively low salary costs per hour of instruction ($13, $15, and $16, respectively); by contrast, costs are relatively high in Denmark ($48), Germany ($49), South Korea ($62), and Switzerland ($48). Salary costs per primary teaching hour in the United States are in the middle of this range at $35. In South Korea, high costs per teaching hour at the primary level are balanced by a relatively high student/teacher ratio (31.2) and a low proportion of current expenditure on nonteaching staff, resulting in below-average expenditure per student (OECD 2000). In contrast, Denmark's high costs per teaching hour at the primary level combine with a relatively low student/teacher ratio (11.2) and an above-average expenditure on nonteaching staff to create one of the highest expenditure-per-student figures in the OECD. There is more variability in salary cost per hour of teaching in upper secondary schools, ranging (among OECD countries) from $16 or below in the Czech Republic and Hungary to $90 or above in Denmark and South Korea. Comparable costs for the United States were $38.

## IT in Schools

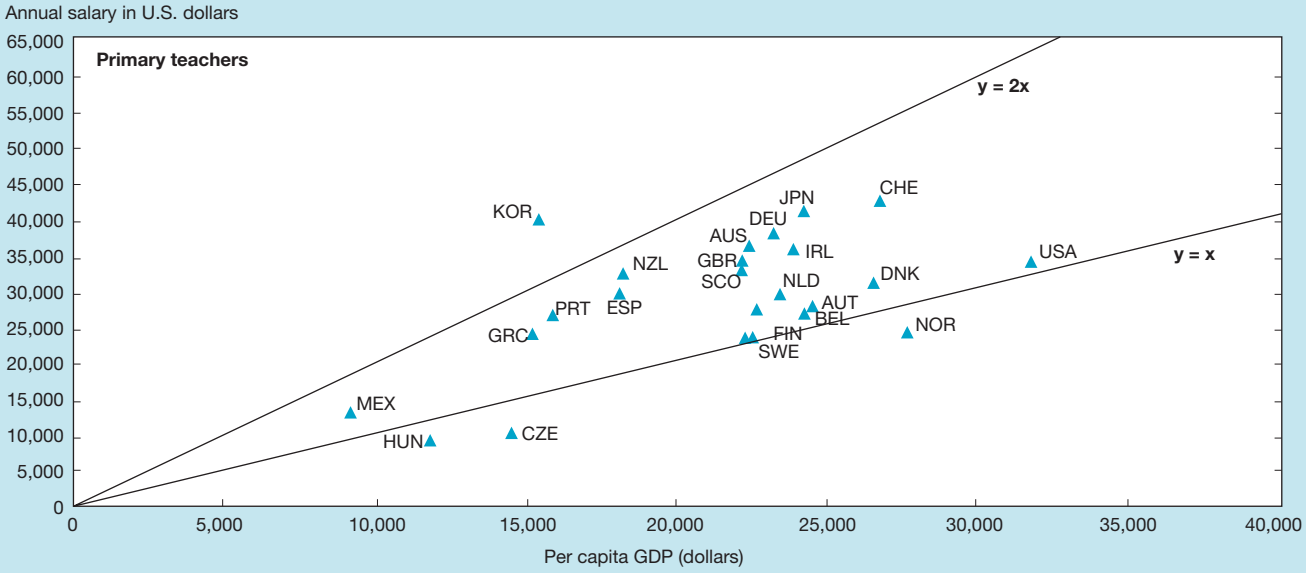
Although myriad approaches have been proposed for improving K–12 education in the United States, one common element of many such plans is more extensive and more effective utilization of computer, networking, and other information technologies (IT) to support a broad program of systemic and curricular reform (President's Committee of Advisors on Science and Technology 1997). IT has fundamentally transformed America's offices, factories, and retail establishments. Although the transformation in schools has been quite modest by comparison, technology and computers are rapidly appearing in schools and classrooms, and their integration into the curriculum is redefining the perception of a quality school (NCES 2000d).

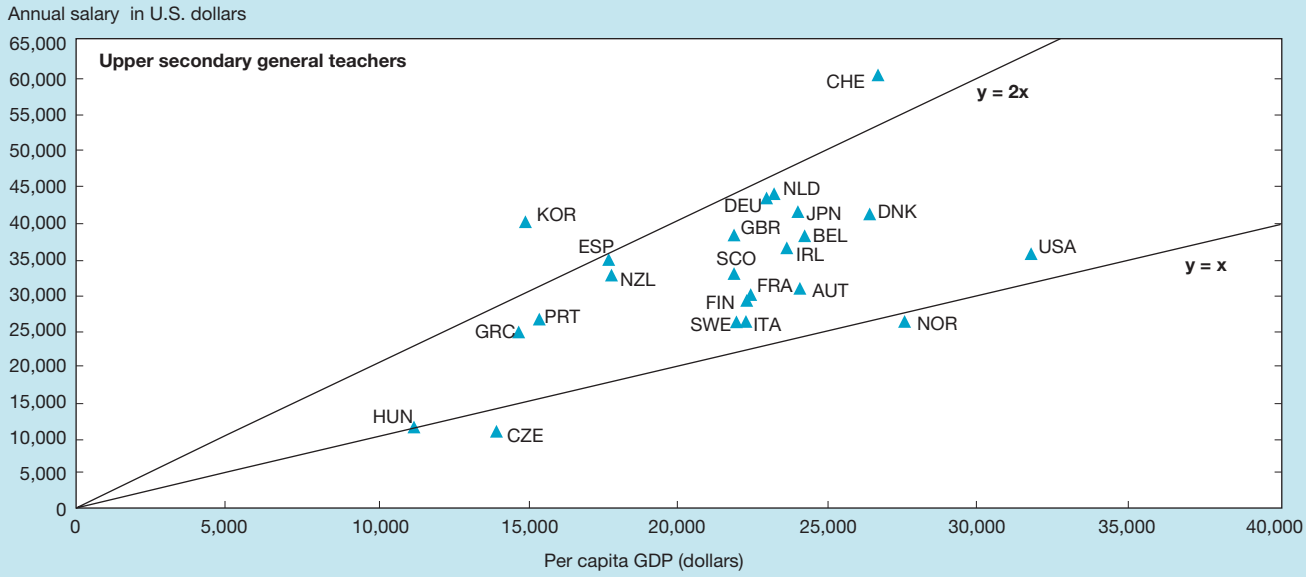
Computers and Internet access are used in a variety of ways in schools, and each use may have an independent effect on student learning. Relatively little research on the effect of technology on learning looks at the uses and effects of Internet access; most research examines the instructional power of the computer to teach discrete skills (NCES 2000d). Numerous studies conducted in the elementary and secondary grades have concluded that student learning is enhanced by computers when the computer is used to teach discrete skills in the style referred to as "drill and practice." The benefits appeared to be strongest for students of lower SES, low achievers, and those with certain learning problems (President's Committee of Advisors on Science and Technology 1997).

Research on the application of computers for developing higher order thinking skills, problem-solving, group work, and hands-on learning activities, however, is less extensive and less conclusive (NCES 2000d). Two studies show positive effects (Wenglinsky 1998; Glennan and Melmed 1996), but a third study concludes that it is not known whether computers can be used for this type of teaching in a cost-effective manner with any "degree of certainty that would be desirable from a public policy viewpoint" (President's Committee of Advisors on Science and Technology 1997). Although it is possible that these studies are less conclusive because teachers are less adept at teaching using these new tools, it is clear that IT is becoming increasingly important in the classroom and that there is widespread interest in how these tools are being applied.

This section first examines student and teacher access to IT at school. Variability in access across high- and low-poverty schools is emphasized. Next, teacher use of IT in the classroom and at home, teacher preparation and training in IT, and barriers to IT use are examined. Because computers are not the only technology used in schools, the section concludes with a discussion of calculator usage in mathematics classes and how this varies cross nationally.

Figure 1-16.
**Annual statutory teacher salaries after 15 years of experience relative to per capita GDP: 1998**




| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Australia | AUS | Germany | DEU | Mexico | MEX | South Korea | KOR |
| Austria | AUT | Greece | GRC | Netherlands | NED | Spain | ESP |
| Belgium | BEL | Hungary | HUN | New Zealand | NZL | Sweden | SWE |
| Czech Republic | CZE | Ireland | IRL | Norway | NOR | Switzerland | CHE |
| Denmark | DNK | Italy | ITA | Portugal | PRT | United Kingdom | GBR |
| Finland | FIN | Japan | JPN | | | United States | USA |
| France | FRA | | | | | | |

GDP = Gross Domestic Product

NOTE: Countries above the y = 2x line had teacher salaries more than twice their per capita GDP while countries below the y = x line had teacher salaries below their per capita GDP.

SOURCE: Organisation for Economic Co-operation and Development. *Education at a Glance: OECD Indicators*, 2000 Edition (Paris: 2000).

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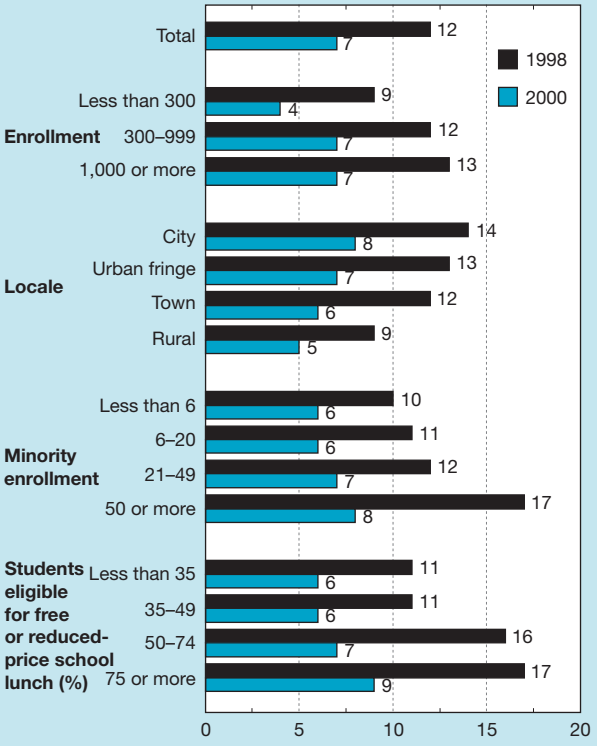
## Access to IT

Computers and Internet access are becoming increasingly available in schools, although the distribution of these resources is not uniform. In 2000, the ratio of students to instructional computers in public schools was 5:1, down from 6:1 in 1999 and a dramatic change from 125:1 in 1983 (NCES 2000d, 2001d). The pace of change is rapid, however, and any measure of access quickly becomes out of date. For example, the ratio of students per instructional computer with Internet access in public schools declined from 12:1 in 1998 to 9:1 in 1999 and then to 7:1 in 2000 (NCES 2001d). Given this rapid degree of change, any data presented in this section run the risk of being a history lesson in disparities in IT access rather than a reporting of current conditions. That said, identifiable disparities can serve as benchmarks for increasing access to technology for all students.

The overall average student-to-computer ratio reported above hides two facts: the distribution of computers per student is skewed (see figure 1-17), and many computers included in that count may be old and have limited usefulness (NCES 2000d). In 1994, for example, 4 percent of the nation's schools had one computer per 4 students, while 46 percent of the schools had one computer per 16.5 students and 10 percent of the schools had one computer per 28.5 students (NCES 2000d). A 1998 study of elementary and secondary schools found that "over half of the computers are out of date.… And in elementary schools almost two-thirds are of limited capacity" (Anderson and Ronnkvist 1999). Older computers often do not have the capacity to link to the Internet or to run current multimedia applications, such as CD-ROM reference and encyclopedia programs (NCES 2000d). Older computers can, however, be used to perform drill and practice sessions and to develop keyboard skills. The ratio of students to instructional computers with Internet access may serve as a reasonable proxy for access to more recent technology.

Figure 1-17.
**Ratio of students per instructional computer with Internet access, by school characteristics: 1998 and 2000**




SOURCE: National Center for Education Statistics, *Internet Access in U.S. Public Schools and Classrooms: 1994–2000*, NCES 2001-071 (Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement: 2001c).

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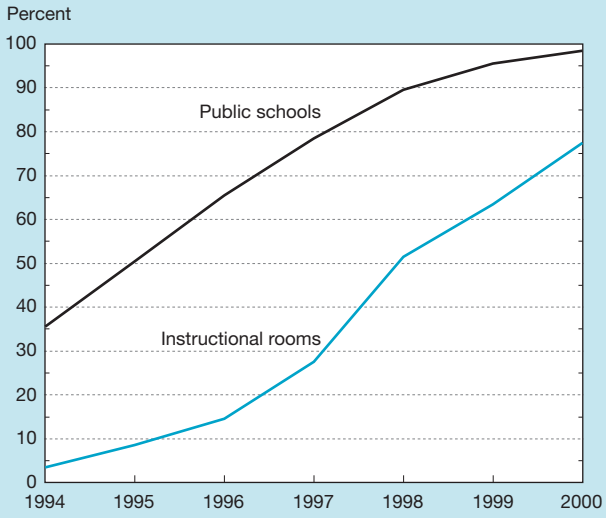
Although the vast majority of teachers have access to computers somewhere in their schools, they appear more likely to use them in instruction if the computers are located in their classrooms. Nearly all public school teachers (99 percent) reported having computers available somewhere in their schools in 1999 (NCES 2000g); 84 percent had computers available in their classrooms and 95 percent had computers available elsewhere in the school. Thirty-six percent of teachers had one computer in their classrooms, 38 percent reported having two to five computers in their classrooms, and 10 percent reported having more than five computers in their classrooms. Teachers were generally more likely to use computers and the Internet if the computers were located in their classrooms than if they were located elsewhere in the school. Furthermore, teachers and students with more computers or more computers connected to the Internet in their classrooms reported using these technologies more often than teachers with fewer computers or fewer Internet connections.

The Internet can open schools to a variety of external resources, and schools have been using it increasingly. Internet access existed at 35 percent of public schools in 1994, but this statistic soared to 98 percent by 2000 (NCES 2001d). (See figure 1-18.) In 1999, however, access to the Internet existed at only one location in 37 percent of schools, thus making regular instructional use difficult (NCES 2000d). Data on this measure are unavailable for 2000.

Although many schools have computers and Internet access, the distribution of these resources among schools with high and low concentrations of poverty is not uniform. A study based on data from the mid-1990s (Anderson and Ronnkvist 1999) found that schools with high concentrations of poor or minority students have fewer computers and are less likely to have Internet access. Although nationally representative data suggest that this gap is narrowing, the data also show that "large gaps…in the quality of the computer equipment available" still exist (Anderson and Ronnkvist 1999, 16). More recent data provide additional evidence for this trend. For high-poverty schools (those with 75 percent or more students eligible for free or reduced-price lunch), 60 percent of all instructional rooms had Internet access in 2000, up from 5 percent in 1996. Schools with less poverty tended to have a larger percentage of rooms with Internet access—77 percent or higher in 2000, up from 11–17 percent in 1996 (NCES 2001d).

Figure 1-18.
**Percentage of public schools and instructional rooms with Internet access: 1994–2000**




SOURCE: National Center for Education Statistics, *Internet Access in U.S. Public Schools and Classrooms: 1994–2000*, NCES 2001-071 (Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement: 2001c).

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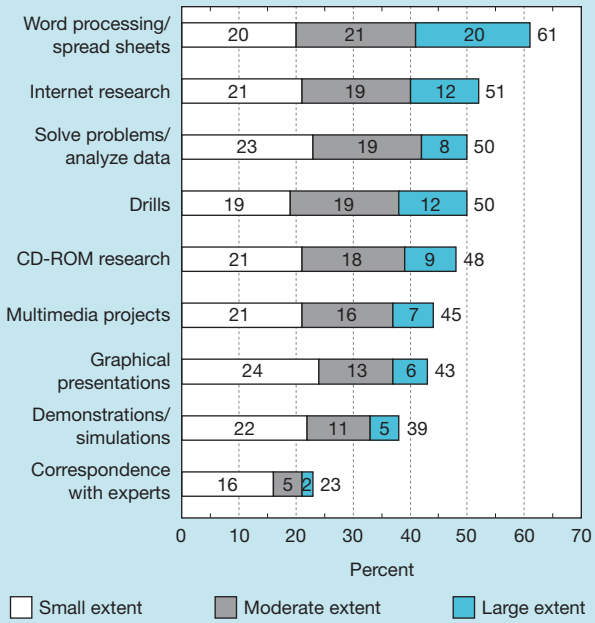
Figure 1-19.
**Extent to which public school teachers assign different types of work using computers or Internet: 1999**




NOTES: Teachers who reported that computers were not available to them anywhere in the school were excluded from analyses. Details may not add to totals because of rounding.

SOURCE: National Center for Education Statistics, *Teachers' Tools for the 21st Century: A Report on Teachers' Use of Technology*, NCES 2000-102 (Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement: 2000g).

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## Teacher Use of Technology

Even though computers are common in U.S. schools, many teachers feel unprepared to integrate technology into the subjects they teach. This section reviews data from a 1999 NCES survey on teacher use of computers and the Internet, describes teacher use of education technology in classrooms and schools, and then discusses teacher use of IT at home.

In 1999, approximately half of the public school teachers who had computers or the Internet available in their schools used them for classroom instruction. (See figure 1-19.) Teachers assigned students to use these technologies for word processing or creating spreadsheets most frequently (61 percent ), followed by Internet research (51 percent), problem solving and data analysis (50 percent), and drills (50 percent). Additionally, many teachers used computers or the Internet to conduct a number of preparatory and administrative tasks (e.g., creating instructional materials, gathering information for planning lessons) and communicative tasks (e.g., communication with colleagues) (NCES 2000g).

Among those with technology available in their schools, teachers in low-minority and low-poverty schools were generally more likely than teachers in high-minority and high-poverty schools to use computers or the Internet for a wide range of activities, including gathering information at school, creating instructional materials at school, communicating with colleagues at school, and instructing students. For example, 57 percent of teachers in schools with less than 6 percent minority enrollments used computers or the Internet for research compared with 41 percent of teachers in schools with 50 percent or more minority enrollments.

Although the vast majority of teachers have computers at home, there is a strong generational difference associated with how teachers make use of these computers and the Internet. Eighty-two percent of public school teachers reported having a computer available at home, 63 percent of public school teachers had Internet access at home, and 27 percent reported that their schools had a network they could use to access the Internet from home (NCES 2000g). Among teachers with computers available at home, teachers with the fewest years of experience were more likely than teachers with the most years of experience to use computers or the Internet at home to gather information for planning lessons (76 percent compared with 63 percent) and creating instructional materials (91 percent compared with 82 percent). Less experienced teachers were also generally more likely than more experienced teachers to use these technologies to access model lesson plans at school and at home.

## Teacher Preparation and Training in IT

Teacher preparation and training to use information technology is a key factor to consider when examining teacher use of computers and the Internet for instructional purposes. In 1999, approximately one-third of teachers reported feel-

ing well prepared or very well prepared to use computers and the Internet for classroom instruction, with less experienced teachers indicating they felt better prepared to use technology than their more experienced colleagues. For many instructional activities, teachers who reported feeling better prepared to use technology were generally more likely to use it than were teachers who indicated that they felt unprepared (NCES 2000g).

Teachers cited independent learning most frequently as the method they used to prepare for technology use (93 percent), followed by professional development activities (88 percent) and assistance from their colleagues (87 percent). Although half of all teachers reported that college and graduate work prepared them to use technology, less experienced teachers were generally much more likely than their more experienced colleagues to indicate that this education prepared them to use computers and the Internet.

Most teachers indicated that professional development activities on a number of topics were available to them, including training on software applications, use of the Internet, and use of computers and basic computer training (ranging from 96 percent to 87 percent). Among teachers reporting that these activities were available, participation was relatively high (ranging from 83 to 75 percent) and more experienced teachers were generally more likely to participate than less experienced teachers. Teachers indicated that followup and advanced training and use of other advanced telecommunications were available less frequently (67 and 54 percent, respectively), and approximately half of the teachers reporting that these two activities were available to them participated in those activities.

Over a three-year period, most teachers (77 percent) participated in professional development activities in the use of computers or the Internet that lasted the equivalent of four days or fewer (i.e., 32 or fewer hours). Teachers who spent more time in professional development activities were generally more likely than teachers who spent less time in such activities to indicate they felt well prepared or very well prepared to use computers and the Internet for instruction (NCES 2000g).

## Perceived Barriers to Teacher Use of Technology

Certain characteristics of classrooms and schools, such as equipment, time, technical assistance, and leadership, may act as either barriers to or facilitators of technology use (NCES 2000g). In 1999, barriers to the use of computers and the Internet for instruction most frequently reported by public school teachers were not having enough computers (78 percent), lack of release time for teachers to learn how to use computers or the Internet (82 percent), and lack of time in the schedule for students to use computers in class (80 percent) (NCES 2000g).[12]

[12] Includes teachers reporting these as "small, moderate, or great barriers" NCES 2000g, figure 6-1.

Teacher perceptions of barriers to technology use varied by a number of teacher and school characteristics. For example, secondary teachers, teachers in large schools, and teachers in central-city schools were more likely than elementary teachers, teachers in small schools, and teachers in rural schools, respectively, to report that not having enough computers was a great barrier. (See text table 1-6.) Additionally, teachers in schools with more than 50 percent minority enrollments were more likely to cite outdated, incompatible, or unreliable computers as a great barrier than were teachers in schools with less than 6 percent minority enrollments (32 percent compared with 22 percent).

Generally, teachers who perceived lacking computers and time for students to use computers as great barriers were less likely than those who did not perceive these conditions as barriers to assign students to use computers or the Internet for some instructional activities. For example, teachers who reported insufficient numbers of computers as a great barrier were less likely than teachers reporting that this was not a barrier to assign students to use computers or the Internet to a "large extent" for practicing drills (9 percent compared with 19 percent), word processing or creating spreadsheets (14 percent compared with 25 percent), and solving problems and analyzing data (6 percent compared with 13 percent) (NCES 2000g).

Text table 1-6.
**Percentage of public school teachers reporting great barriers to use of computers and the Internet for instruction, by type of barrier and school characteristics: 1999**

| School characteristics | Not enough computers | Outdated, incompatible, or unreliable computers | Internet not easily accessible |
|---|---|---|---|
| All public schools | 38 | 25 | 27 |
| Elementary | 36 | 27 | 28 |
| Secondary | 43 | 21 | 23 |
| Enrollment | | | |
| Less than 300 | 25 | 24 | 21 |
| 300–999 | 38 | 26 | 27 |
| 1,000 or more | 46 | 24 | 27 |
| Locale | | | |
| City | 43 | 29 | 28 |
| Urban fringe | 39 | 25 | 27 |
| Town | 38 | 22 | 23 |
| Rural | 31 | 23 | 26 |
| Minority enrollment | | | |
| Less than 6 | 35 | 22 | 24 |
| 6–20 | 35 | 22 | 20 |
| 21–49 | 38 | 26 | 27 |
| 50 or more | 45 | 32 | 36 |

NOTE: Teachers who reported that computers were not available to them in school were excluded from analyses.

SOURCE: National Center for Education Statistics, *Teachers' Tools for the 21st Century: A Report on Teachers' Use of Technology,* NCES 2000-102 (Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement, 2000g).

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### Calculator Use in the United States and Other Countries

Handheld calculators are owned by almost every student in the United States and are fully integrated into the teaching of mathematics in many U.S. schools. Since 1985, many calculator models have featured built-in graphing software for enhancing teaching and learning by allowing mathematics students to visualize mathematical functions.

The NCTM Curriculum and Evaluation Standards (NCTM 1989) urge the use of calculators to reduce the time spent on paper and pencil methods of calculating so that students can have more time to work on problems that foster development of underlying concepts. NCTM suggests that by using this approach, students develop a stronger basis for understanding how to approach complex problems. Meanwhile, educators who do not share this view have expressed concern that young children in classrooms where calculators are heavily used may not develop proficiency with basic arithmetic operations. See sidebar, "Calculators and Achievement."

Both the NAEP and TIMSS surveys included questions for teachers and students on their level of calculator use in schools. The TIMSS surveys show that 99 percent of 8th-grade students and 95 percent of 4th-grade students in the United States owned calculators in 1995. The range was from 76 percent in Norway to 95 percent in the United States and the Czech Republic. In the United States, many schools provide calculators for use by students who do not own them. School-owned calculators used in 4th-grade U.S. classrooms increased from 59 percent to 84 percent between 1992 and 1996 (Hawkins, Stancavage, and Dossey 1998).

Classroom use of calculators is more common among U.S. elementary school students than among students in a number of other countries that participated in TIMSS. (See text table 1-7.) Although U.S. teachers were more likely than teachers in most other countries to use calculators in the lower grades, about 30 percent still reported that they never use calculators. However, about the same percentage of these teachers reported using calculators to solve complex problems in 4th-grade classrooms, a proportion similar to that for teachers in Canada and England (Mullis et al. 1997).

By grade 8, classrooms in nearly all countries use calculators for mathematics instruction, although the degree to which they are used varies widely. In 1999, 42 percent of U.S. 8th-grade students reported that they "almost always" use calculators in their mathematics lessons (Mullis et al. 2000). This percentage was higher than the international average (19 percent). Compared to the United States, two nations, the Netherlands and Australia, had a higher percentage of students responding that they almost always use calculators in their mathematics lessons. Eight percent of U.S. 8th-grade students reported never using calculators in their mathematics lessons, which was lower than the international average for students (32 percent).

Official policies on calculator use vary across the countries participating in the TIMSS-R; policies include encouraging unrestricted use, use with restrictions, and banning calculator use entirely (Mullis et al. 2000). Official documents of 23 countries included an explicit policy on the use of calculators. (See text table 1-8 for policies in selected countries.) Seven of these countries reported that their curriculum policy allows unrestricted use of calculators (Belgium, Finland, Hong Kong, Israel, Japan, the Netherlands, and New Zealand), and 14 allow restricted use. In Canada and the United States, policy varied across provinces and states, respectively. Several countries' policies do not permit calculator use in the lower grades of their primary school systems. For example, in Japan, calculators are not permitted until grade 5. Other countries reported that the use of calculators in these lower grades is limited so that students may master basic computational skills, both mentally and using pencil and paper.

## Transition to Higher Education

Expectations of college attendance have increased dramatically over the past 20 years, even among low-performing students. More than two-thirds of high school graduates attend college, and a rising proportion have taken a college preparatory curriculum in high school. The use of AP exams to gain college credit in high school has also increased, although research has shown that some colleges are less likely to award AP credit now than in the past. Despite greater numbers of students aiming for college, some college faculty are concerned that today's students are less well prepared in mathematics than previous generations of students. College-level remediation is also on the rise, and policymakers are increasingly concerned about the number of students needing to take remedial courses in college. This section reviews changes in the immediate transition from high school to college over the past 30 years, including changes by sex and by race/ethnicity. The final section discusses the growth of remediation at the college level, a trend that troubles both educators and policymakers who are concerned about the efficacy of the S&E pipeline.

### Transition from High School to College

Because most college students enroll in college immediately after completing high school, the percentage of high school graduates enrolled in college the October following graduation is an indicator of the total proportion who will ever enroll in college. College enrollment rates reflect both the accessibility of higher education to high school graduates and their assessments of the relative value of attending college compared with working, entering the military, or pursuing other possibilities.

Overall, immediate college enrollment rates for high school completers increased from 49 to 63 percent between 1972 and 1999. (See figure 1-20.) Much of the growth in these rates between 1984 and 1999 was due to increases in the immediate enrollment rates for females at four-year institutions (see below).

Some differences in immediate enrollment rates among groups of completers have not changed. The gap in rates be-